zoonotic diseases

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Brief Report

Pasteurella Bacteremia: Clinical Presentation, Outcomes, and Mortality in a Retrospective Cohort

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Simple Summary

Pasteurella species are a common cause of infection in human bite wounds from domestic animals such as cats and dogs. Invasive infections such as bloodstream infection are rare but are associated with poor patient outcomes. Despite their clinical importance, there is a lack of available data on clinical presentations, risk factors and outcomes for patients with *Pasteurella* bloodstream infections. Existing literature suggests that immunosuppression and chronic medical conditions are key predisposing factors. Given the rising prevalence of immunosuppressive states and complex comorbidities in the general population, a clearer understanding of the epidemiology and clinical features of *Pasteurella* bloodstream infection is urgently needed. In this study, we review cases presenting to the Mayo Clinic Health system over a 12-year period, aiming to characterize clinical features, factors associated with intensive care unit admission and adverse patient outcomes.

Abstract

Pasteurella species are facultatively anaerobic Gram-negative coccobacilli residing in the upper respiratory tract of mammals, fowl and domestic animals including cats and dogs. Localized infections with *Pasteurella* species are common but invasive infections are rare. There is a paucity of data available on risk factors, clinical presentations and outcomes with *Pasteurella* bloodstream infection. We conducted a retrospective review of patients with *Pasteurella* bacteremia presenting to our institution. There were 63 presentations (61 patients) with *Pasteurella* bacteremia. Immunosuppression, malignancy and alcohol misuse were common. Rates of admission to intensive care (n = 18, 29.5%) and death prior to hospital discharge (n = 7, 11.5%) were high.

Keywords: *Pasteurella*; bloodstream infection; zoonotic infection

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1. Introduction

Pasteurella species are facultatively anaerobic Gram-negative coccobacilli exhibiting bipolar staining. They are catalase- and oxidase-positive, and grow on chocolate agar (without hemolysis), but not on MacConkey agar. *Pasteurella* species reside in the upper respiratory tracts of mammals, birds, and domestic animals—particularly cats and dogs [1–3]. In humans, *Pasteurella* infections most frequently occur following animal bites or scratches, often resulting in localized skin and soft tissue infections, as well as bone and

joint involvement [4,5]. *Pasteurella multocida* is the species most commonly implicated in human infections and is widely recognized as the predominant pathogen isolated from animal bite wounds in humans [6,7].

Although *Pasteurella* primarily causes localized infections, it can also lead to invasive disease, including bloodstream infections (BSIs) [4,7,8]. Bacteremia caused by *Pasteurella* species represents only a small fraction of reported *Pasteurella* infections, yet carries a disproportionately high risk of severe outcomes [9]. Mortality associated with bloodstream infection is high, occurring in up to one third of patients [10], with deaths due to Pasteurellosis reported to be increasing over time [11].

Despite its clinical significance, data on the risk factors, clinical manifestations and outcomes of *Pasteurella* bacteremia remain limited. Invasive infection has been reported to be associated with immunosuppression, cirrhotic liver disease and medical comorbidities [12,13]. The exact epidemiology and predictors of poor outcomes in patients with *Pasteurella* bacteremia remain poorly defined. The existing literature consists largely of case reports and small case series, leaving gaps in our understanding of its epidemiology and prognostic indicators.

Given the rising prevalence of immunosuppression [14] in combination with aging populations with chronic medical comorbidities, it is important to understand the full spectrum of clinical presentations and risk factors for the development of bloodstream infections. In this study, we present the largest cohort from a single center of patients diagnosed with *Pasteurella* bacteremia to date. We aim to describe the demographic and clinical characteristics of this population, identify characteristics associated with *Pasteurella* bloodstream infection, and evaluate clinical outcomes including all-cause mortality, to inform both early recognition and treatment strategies for this clinical syndrome.

2. Materials and Methods

2.1. Study Design and Participants

We conducted a retrospective review of all adult patients with *Pasteurella* bloodstream infection (BSI) from 1 January 2010 to 31 May 2022 across all Mayo Clinic locations. We utilized Mayo Clinic Advance Text Explorer software in addition to the Clinical Microbiology Laboratory database identify patients with *Pasteurella* spp. BSIs. Clinical data were collected using REDCap electronic data capture.

Characteristics of patients such as sex, age, demographics, and comorbidities, along with clinical presenting features, antimicrobial treatment, duration of hospital stay, and the need for ICU admission, were extracted from electronic medical records. This also included data on all-cause mortality at the time of hospital discharge and at 30 days. We also collected data on reported risk factors for *Pasteurella* BSIs including immunosuppressive medications and medical co-morbidities. For patients experiencing recurrent episodes, data from their initial presentation were included.

2.2. Patient Consent Statement

The study was reviewed and approved by the Mayo Clinic Institutional Review Board (application #22-003777). As per the approval, patient consent was not required for this study. However, those attending our hospital system may choose to have their data excluded from research studies. Those who had not given permission for the use of their clinical data for research purposes were excluded from this study.

2.3. Microbiological Data

Our standard practice involves collecting two sets of blood cultures from each patient. Each set includes two Becton Dickinson BD BACTEC™ Plus Aerobic/F bottles and

one BD BACTEC™ lytic Anaerobic/F bottle, each filled with 8–10 mL of blood. When a blood culture bottle flags positive on the system, Gram staining is conducted, followed by a subculture on specific media based on the Gram stain findings. The identification of *Pasteurella* species during the study period was achieved using matrix-assisted laser desorption ionization–time-of-flight mass spectrometry (MALDI-TOF MS) and/or conventional biochemical methods. Our facility has employed MALDI-TOF MS for species-level identification of *Pasteurella* since 2012. Phenotypic antimicrobial susceptibility testing was conducted by agar dilution, and the results were interpreted following CLSI guidelines.

2.4. Statistical Analysis

Continuous variables were reported as median with interquartile range (IQR) or mean ± standard deviation. Statistical analysis was carried out using SPSS® (version 29) statistical software. Categorical variables were expressed as frequencies and percentages. Associations were reported using Fisher's exact test or Pearson Chi-Square where appropriate. Continuous variables were analyzed using the Mann–Whitney U Test. Binary logistic regression was used to assess outcome predictors. Due to the limited number of outcome events, multivariable analyses were restricted to a small number of clinically selected covariates to reduce model overfitting.

3. Results

There were 63 episodes of *Pasteurella* bacteremia, involving 61 distinct patients during the study period. 50 of the 63 episodes occurred during the latter half of the period studied (Supplementary Figure S1). *Pasteurella multocida* accounted for 62 of the 63 cases, with only one case of *Pasteurella stomatis.* The majority (34, 55.7%) of patients were female. The median age was 68 years (range 23–88, IQR 61–77). 61.9% of cases occurred in those aged ≥65 years. Patient demographics are outlined in Table 1.

Table 1. Clinical and demographic data for patients presenting with *Pasteurella* bloodstream infection.

	***n* = 61**
Age	
Median	68 (IQR 61–77)
Range	23.3–88.7
Race	
White	98.4% (60)
Black	1.6% (1)
Liver cirrhosis	11 (18%)
Alcohol misuse	12 (19.7%)
Diabetes mellitus	19 (31.1%)
End stage renal disease on hemodialysis	1 (1.6%)
Absolute neutrophil count < 1 × 10^9/L in preceding 30 days	4 (6.6%)
Immunosuppression	20 (32.8%)
Treatment for hematological malignancy within 3 months	5 (8.2%)
Treatment for solid organ malignancy within 3 months	4 (6.6%)
Chronic steroid use >30 days	6 (9.8%)
Immunomodulating therapies	4 (6.6%)
Chronic lymphocytic leukemia	1 (1.6%)
Hypogammaglobulinemia	1 (1.6%)
Splenectomy	1 (1.6%)

Note: Bold and italic are to differentiate the subsections from the title sections.

3.1. Animal Exposure

Animal exposure was documented in 54 (86.9%) patients, with 38 (62.3%) exposed to cats and 23 (37.7%) exposed to dogs; 8 patients were exposed to both animals. A bite or scratch prior to admission was reported in 24 (39.3%). Two patients reported animals licking wounds without bites or scratches.

3.2. Clinical Presentation

The most common clinical syndrome at presentation was skin and soft tissue infection in 33 (54.1%) patients (Table 2). This included cellulitis of non-limb sites such as peri-orbital cellulitis, cellulitis of a tracheostomy site, and breast cellulitis associated with prosthetic implant. Concurrent lower respiratory tract infection was seen in 3 (4.9%) patients who presented with cellulitis. Infection of the upper airway was seen in 6 patients, and included presentations of epiglottitis, tracheitis, and pharyngitis. Respiratory tract infection was seen in 19 (31.1%) cases, with lower respiratory tract infection accounting for 13 (21.3%) of presentations overall.

Table 2. Clinical syndromes of patients presenting with *Pasteurella* bloodstream infections.

Skin and soft tissue infection	36 (59%)
Respiratory tract infection	19 (31.1%)
Bone and joint infection	6 (9.8%)
Intra-abdominal infection	4 (6.6%)
No identifiable clinical syndrome	5 (8.2%)
More than one clinical syndrome *7 patients had 2 clinical syndromes* *1 patient had 3 clinical syndromes*	8 (13.1%)

Note: Bold and italic are to differentiate the subsections from the title sections.

3.3. Antimicrobial Susceptibility

Antimicrobial susceptibility testing was performed on 31 isolates of Pasteurella multocida across 10 antimicrobial agents. Overall, 74 of 75 tests (98.7%) returned susceptible results. Resistance was identified in a single isolate tested against ceftazidime, which demonstrated a minimum inhibitory concentration (MIC) of 32 µg/mL. The most frequently tested agents were ceftriaxone (n = 23) and penicillin (n = 22), both demonstrating 100% susceptibility. Meropenem (n = 9) and levofloxacin (n = 6) also demonstrated complete susceptibility across all isolates tested. Full susceptibility profiles and MIC distributions are summarized in Table S1 of the Supplementary Material.

3.4. Patient Outcomes

The median hospital stay was 5 days (IQR 3–9.5 days), with two receiving outpatient care only. Admission to the intensive care unit (ICU) was required in 18 (29.5%) patients and was associated with greater severity at presentation, with hypotension in 50% vs. 7% and tachypnoea in 83.3% vs. 44.2% compared to those not admitted to the ICU. The median age of those admitted to the ICU was 61.5 years (IQR 54.5–71.9) compared with 70.7 years (IQR 62–79.4) for those who were not, suggesting a trend toward younger age among ICU patients, though age was not a significant predictor in logistic regression analysis (OR 0.97, 95% CI 0.93–1.01, p = 0.095). On univariable analysis, cirrhosis was associated with substantially increased odds of ICU admission (OR 6.205, 95% CI 1.532–25.133, p = 0.011). This remained significant when adjusted for age (aOR 4.95, 95% CI 1.095–22.385, p = 0.038). However, the wide confidence interval for cirrhosis suggests some uncertainty in the

estimate, likely reflecting the relatively small sample size. Multivariable comparison is limited by event numbers.

Seven (11.5%) patients died before discharge during the acute infectious episode. When examining predictors of in-hospital mortality, the Charlson Comorbidity Index was not predictive of mortality (OR 1.307, 95% CI 0.935–1.828, $p = 0.117$), even when adjusted for age: (aOR 1.419, 95% CI 0.979–2.056, $p = 0.064$). On univariable analysis, pneumonia significantly predicted death (OR 6.667, 95% CI 1.269–35.035, $p = 0.025$). This association remained significant after adjustment for age (aOR 6.948, 95% CI 1.284–37.90, $p = 0.024$), Neutropenia in the preceding 30 days was a significant predictor of in-hospital mortality on univariable logistic regression (OR 39.75, 95% CI 3.326–475.085, $p = 0.004$). Eleven (18%) patients died within 6 months of initial presentation from any cause, and 16 (26.2%) within one year, likely reflecting a highly comorbid population.

A beta-lactam with beta-lactamase inhibitor was the most frequently prescribed antimicrobial class for definitive therapy, given in 33 (54.1%) cases, followed by cephalosporins in 28 (45.9%) cases (Supplementary Table S2). Dual therapy such as combination levofloxacin and ceftriaxone or amoxicillin-clavulanate was used in selected cases. All patients in this cohort received effective antimicrobial therapy within 24 h of presentation to hospital due to coverage by empiric regimens prescribed. Intravenous therapy alone was given in 28 (45.9%) cases, and 3 (4.9%) received oral antibiotics alone. The duration of antimicrobial therapy was dictated by the clinical syndrome.

4. Discussion

This study is the largest of *Pasteurella* bacteremia from a single health system to our knowledge. Invasive infection of sterile sites with *Pasteurella* is rare, with bloodstream infections making up only a proportion of these infections [9]. *Pasteurella multocida* accounted for the majority of infections in this review, with a single case of *Pasteurella stomatis* blood stream infection in an immunocompromised host, a phenomenon not previously described in the literature.

Respiratory tract infection is the second most common site of *Pasteurella* infection, with pneumonia, tracheobronchitis and empyema also being common [15]. Upper airway infection is not a well-described clinical entity. Twelve cases of *Pasteurella* epiglottitis are reported in the literature [13,16–26], in addition to four cases of tonsillitis [27]. This review adds a further six cases of upper respiratory infection. We highlight a female preponderance (83.3%). While our group had a range of comorbidities, none presenting with upper airway infections were on immunosuppression.

The pathogenesis of invasive *Pasteurella* infection may differ from local infection associated with bites [28]. Only 23.1% with lower respiratory infection, and 33.3% with upper respiratory tract infection, reported animal bites in this study. 86.9% did report animal exposure. Documentation was missing in one case, a limitation of the retrospective nature of the review. It has been proposed that infection resulting from inhalation of animal secretions in susceptible persons is a risk factor for the development of invasive disease [15,29,30]. The proportion of patients presenting with bacteremia localizing to the airway (31.1%) in a highly animal-exposed population, with low rates of reported bite in this review, supports the theory that the airway inoculation is a risk factor for the development of invasive infection. It is important to consider that animal exposure alone is a risk factor for *Pasteurella* infection.

Chatelier et al. [10] reported no cutaneous point of entry in 56.8% of cases reviewed. Similarly, only 39.3% of patients in our overall cohort had a cutaneous point of entry recorded. The majority (87.3%) of patients in our study reported a pet in the household. Additionally, Giordano et al. report eight cases of bacteremia in those with and without

a history of animal bite. A bite was reported in only 1 of 8 patients with bacteremia [8], lending support to the theory that airway exposure is a risk factor for invasive infection.

Mortality rate in this study is lower than other studies reporting on patients with bacteremia [8,10]. Mortality rates in contemporary studies are lower than older reports [13], which may be accounted for by improvements in medical care over time. Notably, 26.2% of patients in this review died within a year of presentation, suggesting that invasive infection occurs in a vulnerable cohort of patients. It is widely acknowledged that medical comorbidities are a predictor of mortality with *Pasteurella* infection. Raffi et al. reported 13 cases of bacteremia, of which 77% had cirrhosis and 15% had hematological malignancy [13]. A total of 18% of patients in this review had a diagnosis of cirrhosis, compared with 11.4% with invasive infection reported by Dernoncourt et al. [31]. Giordano et al. report cirrhosis or malignancy was present in all fatal cases [8].

A major strength of this study is that it is the largest study reviewing bacteremia with *Pasteurella* performed within a single health system. The limitations include the retrospective nature of the review, and we acknowledge that this is a predominantly white cohort from a single health system, which may limit broader applicability. Bias regarding admission to the ICU may be present, with those admitted having a younger age. However, this study reviews real-world practices and so the findings are applicable to larger populations.

5. Conclusions

Pasteurella bacteremia occurred predominantly in older, medically complex patients, and was associated with substantial morbidity and in-hospital mortality. Clinical syndromes other than skin and soft tissue infection were common, including respiratory tract presentations. Animal exposure was frequent, whereas a documented bite or scratch was absent in many cases. These findings broaden the recognized clinical spectrum of *Pasteurella* bacteremia and may assist in early clinical recognition.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/zoonoticdis6020013/s1, Figure S1. Number of cases of *Pasteurella* bloodstream infection per year; Table S1. Antimicrobial susceptibility and minimum inhibitory concentration (MIC) distribution of *Pasteurella multocida* isolates (n = 31); Table S2. Classes of definitive antibiotic therapy administered.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. (The data are not publicly available due to patient privacy).

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BSI	Bloodstream Infection
ICU	Intensive Care Unit

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